

Masterclass on Biodiversity prepared for the Natural History Museum

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To understand why biodiversity loss now poses one of the critical problems facing humans and our planet earth, we need to first define what it is.

Audience Question: What is Biodiversity?

Seek Answers from the audience

Biodiversity describes the variety and diversity of bodies of life, in all its forms that are unique to earth. Biodiversity is the diversity of life itself, and includes everything from fungi, plants, bacteria and animals, birds and insects on land and in the oceans. All these species are necessary to work together to maintain Earth's ecosystems and support life in all forms.

Scientists have estimated there are around 8.7 million species of plants and animals in existence today, and it is this diversity which, as David Attenborough puts it "supplies us with every oxygen-laden breath we take and every mouthful of food we eat".

How is Biodiversity Changing?

According to Stanford University and research by Smith at the University of New Mexico, humans have been causing biodiversity loss for over 125,000 years. Humans and our hominin relatives have hunted the largest mammals to extinction with research showing that the mammals that disappear tend to be 100 to 1000 times bigger than those that survive. By around 15,000 years ago, the average mass of North America's mammals had fallen from 216 pounds to just 17.

This is not a general feature of mammal evolution.

Today what alarms scientists is the pace of this loss which has been increasing in the last 50 years. The World Wildlife Fund Living Planet Report in 2018 reported global wildlife population loss of 60% between 1970 and 2014, with decline steepest in the tropics including central and south America with up 90% decrease in certain species being observed.

As we look in more detail at some history of biodiversity loss, we can see this is a partly a function of the change of land-use. This slide changes over time from 850-2015 and clearly shows the drastic loss of forestation. Less forest and habitats has resulted in less species. Economies have become wealthier in this period and have drawn on more and more natural resources in the process of urbanisation and accommodating expanding populations.

Prompt to Audience: Watch the global land-use change from 850 to 2015 on the interactive graph (slide 5 and 6)

We can also make use of the Biodiversity Intactness Index or the BII which is shown in the following graph from 2015. This measures the average fraction of natural biodiversity remaining. As you can see from the image on the slide, areas such as India and Europe have very little of their biodiversity intact compared with parts of South America, central Australia and northern Canada where they are almost 100% is still intact. This tool is very useful to depict which countries need to conduct the most

change, and when combined with data about areas rich in biodiversity highlight areas of priority to preserve.

In 2019, the UN reported as many as one million plant and animal species now threatened with extinction because of human activity. **It is estimated that the current global extinction rate is 100 to 1000 times higher than the natural rate.** For example: in Europe alone, some 42% of European mammals are endangered, together with 15% of birds and 45% of butterflies and reptiles. Furthermore, the average presence of native species has fallen in most biomes by at least 20% relative to a baseline of populations in unimpacted areas.

Biodiversity loss ranked in the top five risks of the World Economic Forum 2020 Global Risks Report. Though it is a problem often drowned out in the conversations about climate change, it poses very real social and economic costs to our planet that we must urgently address.

Question for Audience: What is at risk with large biodiversity loss?

[Seek Answers from the audience](#)

What is at risk is habitat destruction and species extinction ultimately resulting in the collapse of our ecosphere to the point where it will not support human life.

We have now essentially explored what biodiversity is and what is at risk to being lost in the perilous direction our markets and human behaviour have taken us.

Audience Question: What are the causes of Biodiversity Loss?

[Seek Answers from the audience](#) – [create an order to discuss in more detail](#)

So now it's time to discuss what is causing the degradation of global biodiversity.

It is important to note that it is human activities that have caused the accelerated and growing destruction.

1) The first threat to biodiversity is climate change

Climate change is the long-term change in global average weather patterns that have come to define Earth's climates. Climate change is caused by what is known as the enhanced greenhouse effect, which is when human activities accentuate the natural, and positive, greenhouse effect. The rapid increase in population growth, explosion of use of fossil fuels without markets fully pricing the cost of carbon, increasing industrialisation and consumption, deforestation, expansion of agriculture, have all contributed to climate change, but none more so than humans excessive use of fossil fuels.

As you can see from current graph, atmospheric carbon dioxide levels have fluctuated up to a boundary of 300 part per million until around 1950. The large amount of excessive enhanced greenhouse gas (GHG) emissions coincides with the time that the internal combustion engine was mass produced, and human consumption of fossil fuels radically increased, which has drastically increased the amount of atmospheric carbon dioxide from its previous high of 300 ppm to 409.8 parts ppm which was the 2019 average. This 37% increase in such a short period of time creates the Enhanced Greenhouse Effect and the Anthropocene – the geological epoch denoting human impact on the Earth's ecosystems effects of which include:

- i) global mean temperature increase,
- ii) extreme fires, floods, more frequent and severe hurricanes and tornadoes,
- iii) melting of ice caps,
- iv) sea level rise,
- v) sea temperature rise,
- vi) ocean acidification and coral bleaching,
- vii) salination of inland coastal waters.

These all have disastrous effects on the biodiversity globally.

A good illustration of this are the Australian wildfires of early 2020.

Australia was experiencing one of the most prolonged droughts in history and this coupled with soaring temperatures caused the worst forest fire season on record to occur. Not only were 1 billion animals estimated to be killed and 18 million hectares burnt across the country, but 195 million tons of carbon dioxide were emitted, creating a damaging cyclical process.

In recent times Australia has also been subject to ruinous floods, which have been induced by climate change. At the start of the 2021 Sydney experienced the “worst flooding in 60 years”. Climate change can increase the intensity of rainfall as the “concentration of atmospheric water vapor increases in proportion to the saturation concentrations at a rate of about 6–7%”. The extent of the floods also caused a large number of burrowing animals, such as a wombat, to drown in the floods. 24 inches of rain fell in a 7-day period causing at least A\$500m of damage.

The global average temperature increases have caused the ice at the polar regions to melt (about 90% in Antarctica and 10% in the Greenland ice cap) which not only contributes to rising sea levels but also influences ocean currents. Ocean waters are warming and expanding in volume, eroding coastlines and increasing storms – alarming for the 200 million people who live within a meter of sea level. Megacities near coastal plains or river deltas such as New York, Shanghai, Tokyo, London and Bangkok are at risk, as illustrated nicely by the diagram of Shanghai. You can easily see the extent of loss of land in this vast city of 26.3 million people. The extent of sea level rise is potentially so prominent in these vulnerable cities, that features such as the Houses of Parliament we all know so well, could be submerged under a scenario of 4 degrees of warming.

Sea level rise is a slow-moving process that is extremely difficult to reverse. It will inevitably lead to climate migrants, hundreds of millions of climate migrants. Where will they go and how can we plan these transitions peacefully? Perhaps the Maldives offers an example. The Maldives is an archipelago stretching across 26 atolls in the Indian Ocean with an estimated population of about 500,000 people. With an average ground-level elevation of 1.5m above sea level it is the world’s lowest lying country and the most vulnerable. The Maldivian government has entered into negotiations with several countries to purchase land for the repatriation of its citizens in anticipation of a time when the Maldives are not habitable.

The increased burning of fossil fuels is causing ocean acidification as the oceans absorb more carbon dioxide, reducing the oceans pH levels. Ocean acidification particularly negatively effects our coral reefs which are home to about 25% of all marine species making them one of the most diverse habitats on earth, but also one of the most vulnerable.

Score found that “over 50 percent of the world’s coral reefs have died in the last 30 years and up to 90 percent may die within the next century”. Scientists estimate coral cover across the 1,400 mile

long Great Barrier Reef in Australia has also reduced by at least 50% since 1995 with the steepest falls coming after mass bleaching events in 2016 and 2017. Tragically a great deal of this loss is deemed permanent.

Saltwater intrusion is the movement of salt water into freshwater aquifers. Excessive salination of inner coastal waters and soils – caused by rising sea levels and more frequent and more intense storms from climate change – both through surface and ground water sources may:

- i) Diminish the availability or quality of course of fresh water for drinking causing public health issues;
- ii) Affect the ability to grow crops; and
- iii) Disrupt the fresh water required for supporting coastal biodiversity.

This is especially a problem for highly populated countries such as Bangladesh with large low-lying coastlines, tropical monsoon climates and an average altitude of less than 10m above sea level.

Exploring Solutions to Climate Change: The En-ROADs model

Interactive Audience participation about climate change solutions using the En-Roads model.

<https://en-roads.climateinteractive.org/scenario.html?v=21.12.0>

2) Human exploitation of Nature Capital

Another factor that is causing this mass degradation of our biodiversity is the reckless way in which humanity has exploited nature capital. Economies and industries for years have taken from nature, acting as if it is an infinite source. Nature can restore and rebuild but requires time to do so. Since the 1950's our consumption of nature has outstripped Nature's rate of restoring and replenishing at an ever-increasing rate leading to mass biodiversity loss. This can be seen in many forms but two examples depict the issue well: commercial fishing and destruction of forests.

i) **Oceans and Fishing**

Audience Question: What problems can you think of in the fishing industry?

i) Overfishing in certain waters

According to the World Wildlife Fund (WWF) two-thirds of the world's fish stocks are either fished to their limits or over-fished. Overfishing of some species such as sharks, which are rapidly in decline, can upset the entire marine ecosystem.

For a healthy and safe planet, scientists agree that 40% of oceans needs to be protected by a "no take" policy to allow for the restoring of fish stocks. Currently, only 2.8% of the world's oceans are completely protected from commercial fishing, mining, oil drilling, and other destructive activities, despite the U.N. goal to protect 10% of the world's oceans by the end of 2020.

ii) Inappropriate fishing methods

Many fishermen employ the use of explosives as well as large dragnets, and bottom trawling which kill or capture all fish in their nets generating vast quantities of "bycatch"

– unintentionally capturing fish or marine animals which are not wanted and usually wasted. These process can also destroy coral, sponges entire aqua ecosystem in their wake. In many areas of the world they are apparently not accountable to anyone.

iii) Old Fishing Lines

Fishermen are usually charged for waste disposal of old fishing nets on land and so choose to dump in the ocean adding to the huge burden of waste and plastics in the ocean which are not biodegradable and are hazardous to marine life.

ii) **Forests**

Forests are essential to the carbon cycle, acting as carbon sinks to balance the combination of oxygen and carbon dioxide in the atmosphere and are often referred to as the lungs of the earth, thus the destruction of this particular biodiversity can be extremely damaging. They capture 7.6 billion tons of carbon dioxide which is about 25-30% of human emissions. In emerging economies, such as Brazil, rainforests are being exploited at an alarming rate for economic gain. In 2019, enough rainforests were destroyed every minute to fill 30 football pitches and rainforests like all ecosystems have their own tipping points. Too much deforestation and the natural rain they generate ceases changing their ecosystem with one effect being greater temperature variation between day and night which is potentially fatal to many inhabitants.

The destruction of rainforests also brings humans closer to wild animals not usually in contact with increasing the risk of zoonotic disease transmissions like SARS, MERS and COVID19.

3) Unsustainable Population growth

The third important factor to take into account is the growth in population. The global population has grown from 1 billion in 1800 to 7.9 billion in 2020. The relationship between population and biodiversity loss is very simple: when there are more people on the earth, there is more consumption requiring more exploitation of nature.

4) Waste and Use of Plastics

Since the 1950's an estimated 6.3 billion tonnes of plastic have been produced worldwide of which only an estimated 20% has been recycled or incinerated. As of 2020, the global mass of produced plastic exceeds the biomass of all land and marine animals combined. Large amounts of plastic waste and their ingredients are pervading our land, oceans and waterways and are ingested by, or suffocating and entangling many forms of marine wildlife, including birds affecting up to 90%. Once ingested marine wildlife have no means to excrete plastic waste and most die of starvation as their stomachs are filled with plastic debris. UNESCO estimates that over 1 million marine animals are killed each year due to plastic debris and calculates there is over 100 million tonnes of plastic in the oceans.

Plastics can take at the least between 450 and 2,000 years to decompose meaning that we need a significant program to remove plastics from the oceans and programs to stop more plastics from entering our waterways.

Audience Question: Why we need to take action now
Take down answers and explore some in more detail

The reasons to take immediate action are seemingly limitless! We have narrowed a few down of the most important:

1) Firstly: The rights to nature.

More specifically, who has the rights to nature? Do humans have the right to take mastery over the ecosystems - destroying and consuming without thought about impact or control?

But what about the rights that we all have as humans, to enjoy and derive pleasure from nature leaving it undisturbed -the rights that I have... the rights that you have...?

‘The bird watcher, the suburbanite who derives joy from birds in his garden, or the explorer of wild regions might be at odds with the hunter, the fisherman, or anyone that takes from nature and has therefore deprived others of pleasure in the future to which they may claim a legitimate right.’

And what of the rights of all species to exist in balance in the ecosphere without destruction by humans? As we have discussed we have not understood and valued well enough the time and cycles of nature to replenish nature’s stocks. We have overconsumed and paid little to no price – until now. E.O. Wilson (an American Biologist, recently deceased, a great man who pioneered nature writing, the real Darwin of the 21st Century) suggests that we should ‘consider all losses in the natural world as a diminution of humankind, since the legacy we leave for our descendants will be an impoverished one’.

Secondly, I will explain the cascading effects biodiversity loss causes:

- 2) The extinction of a specie** may have unforeseen consequences that snowball into the destruction of entire fragile micro-ecosystems.

IF POSSIBLE: Introduce NHM’s PREDICT model and invite audience to use with the moderators’ guidance to explore

Rachel Carson, in the ‘Silent Spring’ uses the example of salmon in the Miramichi River in New Brunswick. She expands on the so called ‘invisible impacts’ of the eradication of the budworm on species further up the food chain. In New Brunswick in 1953, the chemical pesticide DDT, was sprayed over large surfaces of vegetated land in order to save the forests from a local pest – the budworm. However, as a result of this insecticide spraying to remove the forest eating worms, no insects remained for the fish to eat in the local streams, specifically salmon. Birds also suffered with little food to maintain themselves.

It is very clearly demonstrated here, how an impact on one species, can have further, and invisible impacts on other species in such a delicately balanced ecosystem.

This brings me onto my next point:

- 3) Human dependency for survival on Biodiversity and Nature**

- E.O. Wilson, writes ‘We need ants to survive, but they don’t need us at all’
- Healthy ecosystems perform many vital functions for human life: clean our water, purify our air, regulate the climate, insects pollinate our fruit and crops, mangrove forests prevent coastal flooding. Nature is also a source of a great many medicines we use in practice today.
- Biodiversity is the key indicator of the health of an ecosystem. If our ecosystem reaches a ‘tipping point’ humans cannot survive.
- Put simply, we must at least maintain current levels of biodiversity for our survival...!

Having established why we need to protect biodiversity and delicate ecosystems; we can now discuss why we must take action **SOONER rather than LATER**

1) Time-Lag

- It is important to understand that we are currently sitting in an ecological time-lag. An ecological time lag relates to the re-balancing of an ecological system, following a change.
- In this case the change would be an increase in anthropogenic environmental degradation and habitat destruction
- We are currently in this time lag. We have not yet witnessed the worst effects of existing human activity on nature, and species extinction.
- The longer we prolong action to combat humankind’s destruction throughout the Anthropocene, the more severe the species extinction and biodiversity loss will be.

All ecologists, biologists and environmentalists will agree – that we must act sooner rather than later to combat largescale biodiversity loss in the future and prevent crashing through irreversible tipping points.

2) The Urgency of Biodiversity:

Research by Andy Purvis investigated three Scenarios for combatting Biodiversity Loss to make the point that not only do our risks increase the longer we wait to take action, but our costs to act substantially increase too.

- **Immediate Action Scenario:**
 - Act now to stabilise biodiversity at current levels by 2050, Action beginning ASAP, 2021 (light blue line on the graph)
- **Delayed action Scenario:**
 - Commence actions to combat biodiversity loss in 2030, 10 years later than the immediate action scenario, to stabilise levels of biodiversity, again, by 2050 (pink)
- **Immediate High Ambition Scenario:**
 - Start in 2021, or asap, as with the immediate action scenario, however we go beyond just preserving current levels of biodiversity, but we seek to improve them by 2050 (dark blue)

The delayed action scenario, which many individuals would argue we are heading towards, comes with far more negative consequences and drawbacks compared to the alternative immediate Action based scenarios.

WHY?

Any delayed scenario would require a much more intensive approach to combatting biodiversity loss – more people, more resources, more strategies and processes, and it would also carry a much higher risk about what can be achieved. Already we require an historically unprecedented level of

coordination between nations in order to create agreements and movements that achieve results. Every day of delay make this job harder.

By delaying we also risk moving through nature tipping points we do not understand or control.

And finally much more financial investment would be needed in the delayed scenario. Purvis estimated this to be 'twice as expensive to delay action to stabilise biodiversity intactness globally' than it is to act today.

- As an example, increased costs include the cost of land conversion. 70% more land would be required for conversion and protection due to the more intensive approach that must be taken. Furthermore, a ten-year delay would mean even more land would have been deforested in that period, requiring greater efforts to convert back.

We must do better! We all have so much to lose if we do not take immediate action and so much to gain if we do. So what can we do.....

Audience Question What kinds of actions can we take?

Take down answers and explore some in more detail

And now for the good news! We have just heard the urgency of our situation and how we must take immediate action; however, what kind of actions can we take? We will now focus on the actions that you can take on a micro and personal level and then outline what actions needs to be taken on a macro level by governments worldwide.

Micro/Personal level

Personal Actions:

Audience discussion

1. Buy second hand, buy less and wear clothes to last – stop buying unnecessary extra goods. Waste less.
2. Walk, Cycle or Take Public Transport when and where possible - by virtue of living in London, we all have access to most forms of public transport, so try and utilise these forms of transport which help reduce your carbon footprint and overall emissions.
3. Drive Smart –If you decide that you must drive, then plan your journey beforehand and try to drive smoothly, avoiding sudden changes in speed to reduce your fuel consumption
4. The same can be said about air travel – try to avoid it through other, more environmentally friendly means like trains, boats and cars and if you must fly purchase carbon offsets through credible accredited schemes.
5. Beware Driving Electric Cars – Electric Cars can be misleading. Electric cars increase the demand for electricity, and if this electricity is not coming from renewable sources such as wind and solar, this can increase the demand for coal powered electricity and therefore increase GHG emissions.

Actions at home:

Audience discussion

6. Recycle/Buy Sustainable – Try to purchase products that are made with recycled materials and are ethically/sustainably sourced. Paper, wood, and metal can all be recycled, so start your purchasing there to make a difference. As we have learned plastics have invaded our waterways and marine species, avoid plastics as much as you can and be very thoughtful about how you dispose of them. Recycle as much as you can. Check with your local council about different rules and regulations about recycling and encourage friends and family members to also recycle their waste.

Let me tell you an interesting story about waste. Andrew Jones - the co-founder of Climate Interactive decided to do a personal experiment. His goal was to carry around with him the waste he created over a week, to get a better understanding of just how much waste he was creating. So, every time he would normally use the bin, he placed his rubbish in a bag which he took with him everywhere. What he quickly found out was just how much waste he created in a single day and therefore, because he wanted to carry as little as possible, he adapted his behaviour to minimise the waste he was generating. Imagine doing this experiment yourself – it would be very telling.

7. Eat more plant-based food, especially reduce red meat consumption. Reduce food waste, don't overbuy
8. Be energy efficient in your home for example, turn lights off in rooms you are not in, properly insulate your home and look into govt subsidies for placing solar panels on your roof to supplement your energy demand.
9. Be water efficient such as turning your shower off when washing your body, only put your dishwasher/washing machine on when it is fully loaded.
10. Research your energy provider and switch to renewable sources

Actions in Community:

Audience discussion

1. Volunteer / Donate - There are probably plenty of organizations in your area that are working toward a greener tomorrow. You just have to look for them. Volunteer your time and help improve the area where you live. If donating your time is not enough, consider donating some money to non-profit organizations that are fighting to protect biodiversity around the world. There are many organizations that protect land, sea, and air in favour of a better tomorrow.
2. Become more informed, spread positive information about what can be done. Empower others to act.
3. Lobby local businesses and politicians to take affirmative actions.
4. Volunteer for nature protection programs

Macro:

1. Governmental Protection of our worldwide Biodiversity

Governments must immediately take responsibility of their own natural environments and implement schemes to protect their own biodiversity. "Countries should double their protected zones to 30 percent of the Earth's land area, and add 20 percent more as climate stabilization areas, for a total of 50 percent", according to a report published by National Geographical (Leahy, 2019)

Developing countries may argue that these restrictions are too onerous. Wealthy countries, such as the UK, who have already destroyed their biodiversity for economic gain, should now subsidise these

zones to protect their biodiversity so vital to all of us. We need a Global Biodiversity Governing Body that the developed world substantially contributes to, to finance the protection of designated biodiversity rich areas of the world.

As we have previously mentioned for a healthy and safe planet, scientists agree that 40% of oceans needs to be protected by a “no take” policy. Currently, only 2.8% of the world’s oceans are completely protected from commercial fishing (Moffitt, 2014). Protected zones need policing to ensure compliance and we need a global ban on certain ruinous fishing practices. We also need a global task force to clean out the 100 million tonnes of plastic waste in the oceans – an enormous task.

We have explained that the climate crisis is having a very significant effect on biodiversity loss. To prevent this worsening, we must remain “well below 2 °C” of warming -preferably 1.5 °C, according to the Paris Agreement; however, on our current trajectory, research estimates that by the end of the century we will be beyond 3°C of warning.

To prevent this catastrophe, government must immediately stop subsidising fossil fuels, must outrightly ban the use of coal and should redirect this subsidy into more renewable and climate technology. In 2018/19 alone, the UK government channelled US \$2.6 billion to fossil fuels via its export credit agency (Pantuliano, 2020).

In a nutshell we all can lobby our governments to protect our oceans from harmful commercial fishing practices, protect global forests from deforestation, radically reduce enhanced greenhouse gas emissions polluted our atmosphere and we must eradicate waste and inefficiencies in our global supply chains.

2. Fully price the true cost of Biodiversity Loss

Nature capital is not accounted for in current governmental economic models and metrics. Its use is largely not priced or charged and so its loss has been “invisible” to us. Biodiversity provides the natural capital that is fuelling our economic growth. However, it is also true that the negative environmental externalities of growth are undermining the sustainability of our economic model and are calling into question traditional measures of wealth and development, such as Gross Domestic Product (GDP). Based on current estimates, the world’s ecosystems provide benefits worth an estimated \$125 trillion to \$140 trillion a year – the equivalent to more than one-and-a half times global GDP. (Costanza, et al., 2014) That is a vast asset worth protecting.

Natural capital is an asset which does not depreciate and holds large intrinsic value. Our first task is to create ways to measure nature capital and services. Fortunately, there is an emerging field of research around measuring and quantifying what various ecosystems services are worth. Geoffrey Heal argued that one way to measure value, is estimate what economic effect would be left if the biodiversity was removed.

Two examples are:

i) Pollinators

Researchers have estimated the worldwide loss of all pollinators would lead to loss of US\$217bn annually from reduction in crops. Reduced output is likely to drive food prices higher making this estimate a lowball figure, likely doubling this annual cost. An asset with an annual income stream of this magnitude would be valued at least US\$9 trillion.

ii) Forests

Forests are a carbon sink and absorb about a quarter of all emissions of carbon dioxide. Conservatively pricing carbon at US\$35 per tonne would value forests at approximately US\$250bn per annum, with an asset value of about US\$10 trillion. Many economists would argue that the carbon price should be a multiple of US\$35 per tonne valuing the forests value considerably higher.

Remember this is just two aspects of nature, so you can imagine the enormous value of the whole of our planetary biodiversity. Recent research by the World Bank estimates that the global economy could lose as much as \$2.7 trillion per year by 2030 if countries continue to destroy biodiversity at their current rate.

- Economic problem – we are not fully pricing the true cost of our actions, which economists need to fix soon.
- Economists need to come up with new economic metrics which measure nature capital and therefore we can estimate the cost of exploiting natural resources and create charging, taxing and financial penalties for use of and overuse of nature assets.
- Having collected large pools of capital for nature use, we can then direct this money to programmes designed to protect and regenerate our natural resources.

Conclusion

Biodiversity in all its vivid colours, majesty and glory and splendid functionality is not only what makes of ecosystem function it is what makes this blue planet likely unique in our universe.

As we have discovered. Biodiversity loss comes at a high cost.

We must all urgently take actions to reverse this manmade phenomenon. As David Attenborough states “no single species in the whole history of life has been so successful and so dominant” than the human race, which emphasizes our duty to respect and protect our planet. It is not sufficient to merely protect the survival of humankind, but we have a moral responsibility to protect all species. And we now know that in doing this, humans will also ensure the protection of the environment we need to survive.

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